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17. ABSTRACT (MAX. 250 WORDS)															
The specifications and operation of Boulder City's divisible auditorium are presented. In 1956, with the threat of a sharp enrollment increase, consultants were brought in to Boulder City to develop specifications for a proposed new building. The potential need for more instructional space had to be reconciled with the existing need for an auditorium. The building had to have auditorium-assembly space and large-group instruction spaces and also had to have a utilization factor high enough so that the building could act as a hedge against future bulges in enrollment. Beginning with a conventional auditorium, the planners designed a wedge-shaped seating area divided first by an audiovisual core bisecting the wide end of the wedge, and then by two movable partitions separating the rear alcoves on either side of the audiovisual core from the main seating area at the front of the auditorium. Because the new facility can be divided at will and at once, it lends itself to types of instruction for which a standard auditorium would be too large, a standard classroom too small. The partial subdivision created by a permanent split-level core with audiovisual workshop above and lobby below is completed by two operable walls, which block sound so effectively that all three subdivisions can be used at the same time. The resulting flexibility boosts the utilization of the building from the 10 percent which is usual for a high school auditorium, to a potential approaching 100 percent.															
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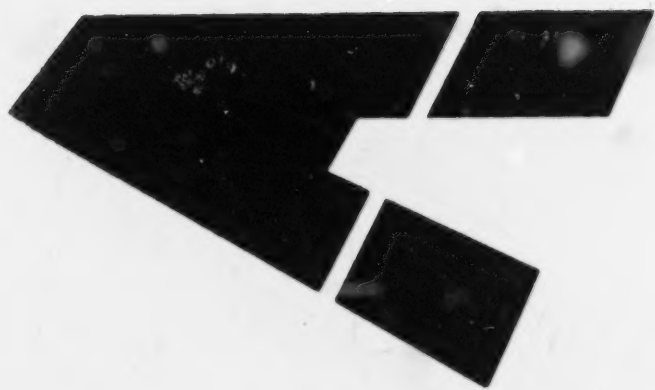
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A Divisible Audiovisual Boulder C

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A Divisible Auditorium / Boulder City, Nevada



1 auditorium divided by 2 operable walls = 3 rooms for instruction

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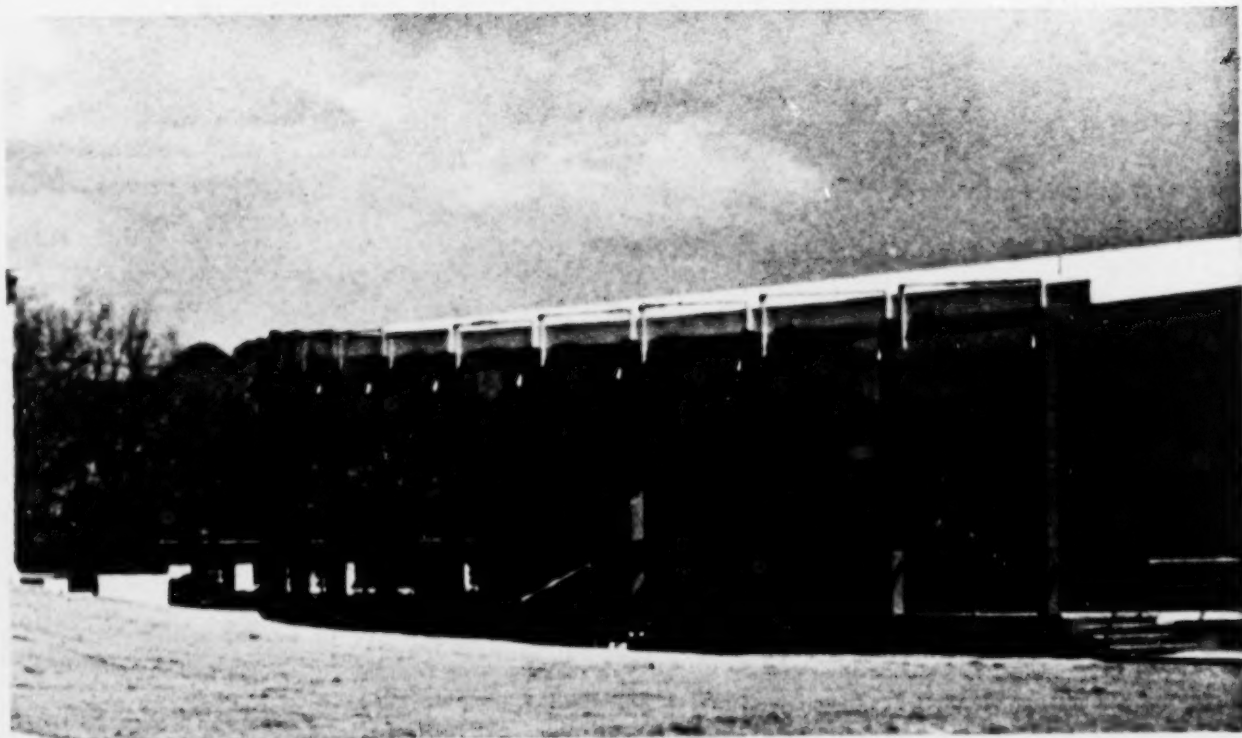
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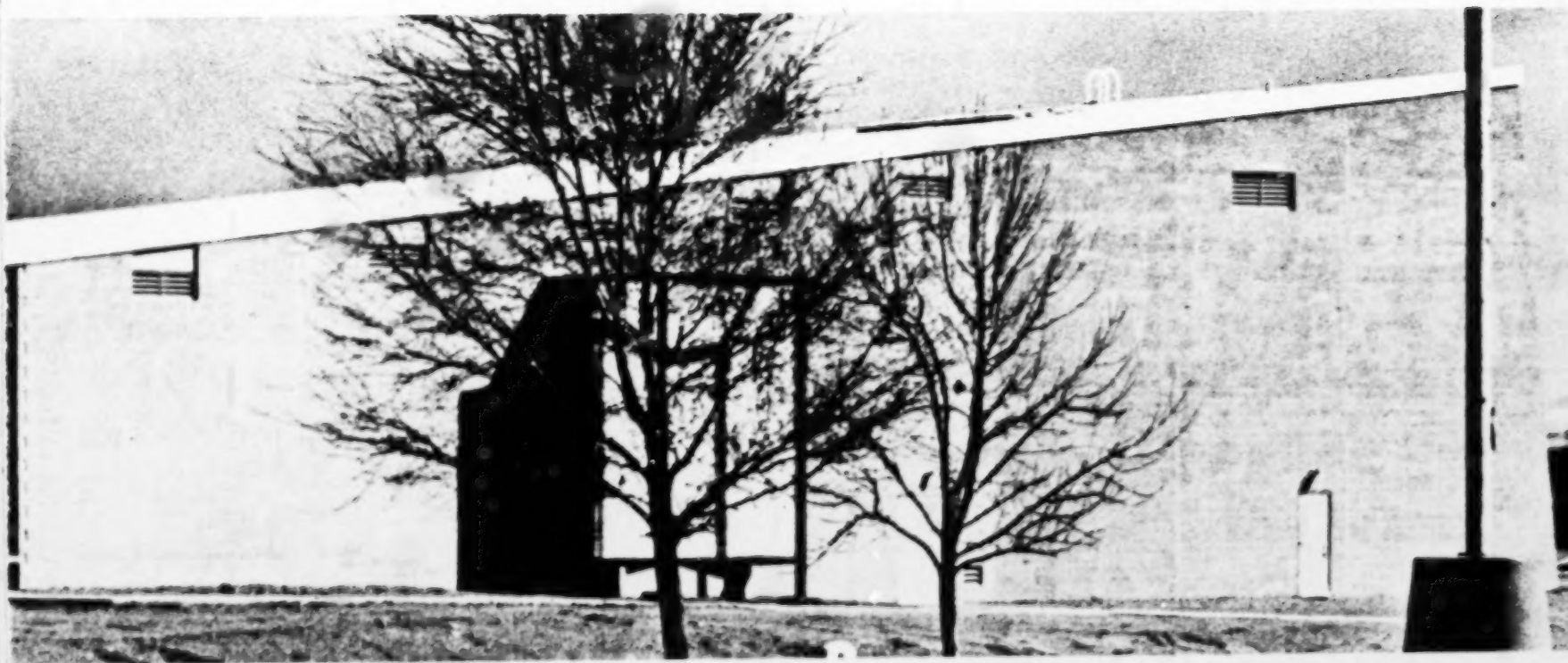
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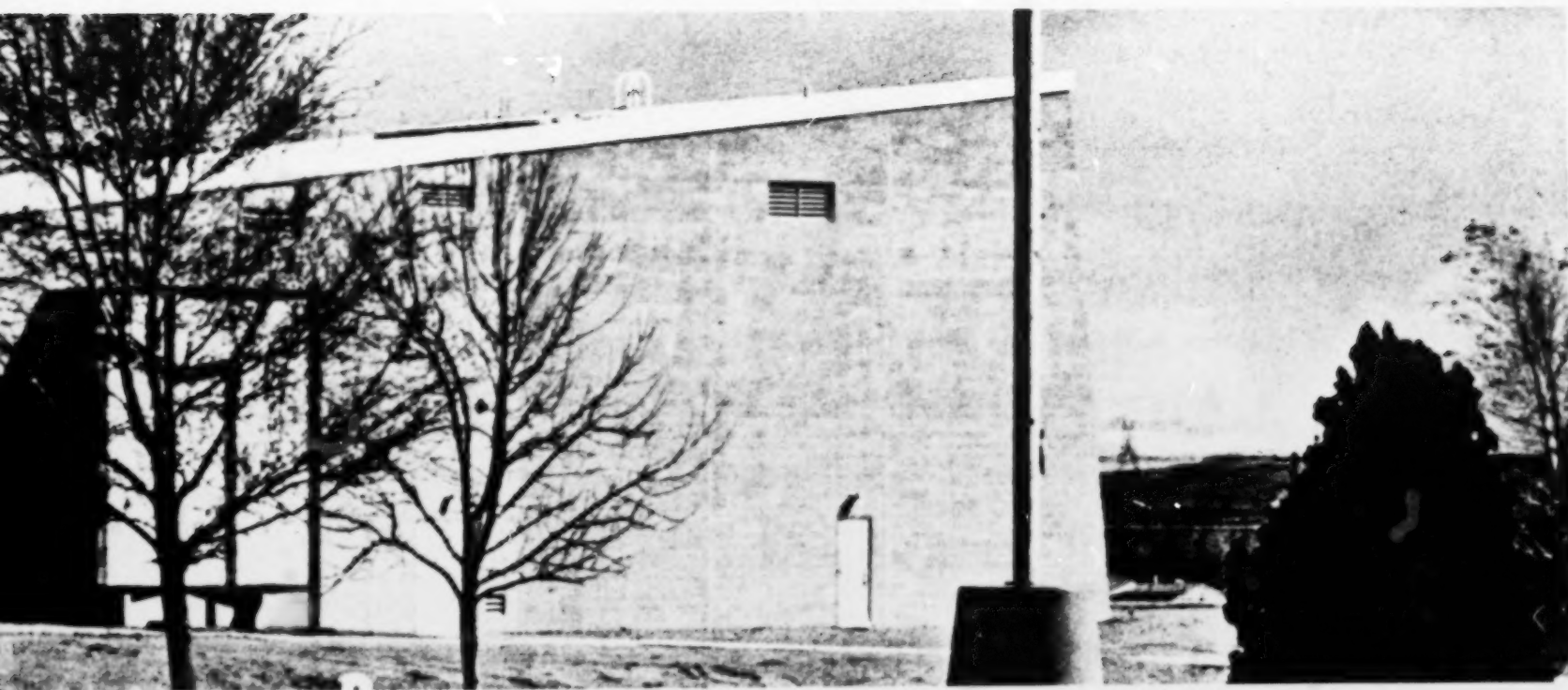
Case Studies



A Divisible Auditorium / Boulder C

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Case Studies of Educational Facilities #4



A Divisible Auditorium / Boulder City, Nevada

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Experiment with Space

The 514 students who swarmed into Boulder City (Nevada) High School's new auditorium on the morning of February 20, 1962, sat with their eyes riveted to television screens and their attention fixed on Colonel John Glenn's whirl around the world. The suggestion that they, too, were taking part in a significant experiment with space would have been met by impatient shrugs and s-s-sh's, for no earth-bound building can compete with a space-bound capsule when it comes to capturing a teenager's imagination. Yet the auditorium in which these teenagers sat is an important stride forward in educational space.

As Dr. J. Lloyd Trump, author of the much-discussed Trump Plan* for redeploying space, time, and teachers in the secondary school, put it, Boulder City's new building is "as different from the conventional auditorium as night is from day." The difference, though, lies not in architectural pyrotechnics, but in two operable walls.

Because the operable walls add and subtract space quickly and automatically, the auditorium can easily be converted to a flexible combination of large-group instruction spaces. And because the walls block sound as completely as they block sight, these spaces are independent enough of one another so that ordinarily conflicting activities can be carried on in adjoining spaces at the same time.

As a result, the school's teaching program can break out of the 30-student boxes in the existing plant. The instructional capacity of the plant itself is increased by the equivalent of at least five classrooms, according to the estimate of R. Guild Gray, who was Superintendent of the Clark County School District when the project was being planned. And the new building, which would stand idle nearly 90 per cent of the time if it were reserved solely for the school-community activities usually conducted in a high school auditorium, is ready for educational use throughout the school day.

The Boulder City project promised these advantages from the very beginning. Since the experiment also had implications for many schools across the country, Educational Facilities Laboratories assisted the Clark County School Board in planning the project, so that its full potential might be realized without undue strain on the district's planning budget.

A Setting for Experiment

The genesis of Boulder City's divisible auditorium dates back to 1956, when Boulder City and the other 13 independent school systems scattered over Clark County's 7,927 square miles were consolidated in a single school district. This new county-wide school district is as large as the states of Connecticut, Delaware, and Rhode Island combined, but it is not only distance that separates the communities within its borders. In addition to Boulder City, the school districts brought together under Clark County's administrative wing included long-isolated Mormon farming communities, the ghosts of once-prosperous mining towns, vast federal enclaves, the middle-sized industrial city of Henderson, and Las Vegas, which is the county's seat, the state's largest city, and the nation's gambling capital.

The peculiar problems stemming from the distance, and disparity, between the charges of the new administrative unit were compounded by the problems that plague school districts everywhere: rising enrollments, rising building and operating costs, and rising educational standards. To relieve existing overcrowding while allowing for a continuing growth rate of 15 per cent per year; to replace the makeshift barracks classrooms in Las Vegas and the one-room schoolhouses in some rural areas; to remove the educational inequalities among the county's far-flung communities; and to improve educational quality throughout the district, the new school administration called for a crash construction program, and brought in outside consultants from EFL's Western Regional Center at Stanford University to assist the superintendent and the board in assessing the district's long-term building needs.

According to the master plan drawn up by the district and its consultants, Boulder City's slice of the building pie was a new music, drama, and arts center

*See *Focus on Change: Guide to Better Schools* (Rand McNally & Company, 1961), a report by J. Lloyd Trump and Dorsey Baynham on the activities of the National Association of Secondary-School Principals' Commission on the Experimental Study of the Utilization of the Staff in the Secondary School.

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to be constructed on the same site with the existing junior-senior high school. This recommendation was solidly based on the school's conspicuous lack of adequate space for assemblies, and lack of adequate facilities for the teaching and practice of the performing arts. But because of Boulder City's peculiar economic and legal status, the planners also suggested that a watchful eye be kept on the town's future development.

Boulder City was a depression baby, born of Boulder (now Hoover) Dam in the early 1930's. Its infancy was devoted to the construction of the dam, and its childhood and adolescence were spent in ministering to the giant hydroelectric project. Homes were built on land leased from the federal government. Federal agencies provided and maintained police and fire departments, streets and roads, sanitation facilities, and utilities. Federal money dispensed through Public Law 874, plus a tiny tax on personal property, supported the schools. Except for those who provided the miscellaneous services needed by any sizable community, its working residents were government employees — engineers, scientists, and other technical and professional workers responsible for the care and feeding of Hoover Dam and its ancillary installations.

Like most towns dependent on a single stable enterprise, Boulder City was growing steadily, but very slowly. So long as the federal government's stewardship over town land precluded any sudden influx of population through new industry or new residential developments, its school system was not faced with a pressing need for more classroom space to keep pace with expanding enrollments.

But it was faced with the need for improving teaching facilities and methods to keep pace with the aspirations of an academically oriented, upper middle class community. (Some three-quarters of Boulder City's high school graduates pursue their educations beyond the secondary school level.) In 1956, when Clark County's master plan was developed, the parental push for better and better-rounded education was the major force behind the school district's decision to add an auditorium to Boulder City High School.

The need for such a facility was clear. Neither the school nor the community had an auditorium and stage suitable for speech or music productions. So, while the

The 8,000 square miles encompassed by the Clark County consolidated school district includes 14 communities which are separated not only by hundreds of miles of desert, but also by the diversity of their interests — from government to gambling, farming to electronics. Boulder City nestles at the eastern edge of the county, near Lake Mead, the giant reservoir created when Hoover Dam bottled up the Colorado River

performing arts could be preached, they could not be effectively practiced. In a pinch, the gymnasium could be — and was — pressed into service for large meetings and assemblies, but the absence of a stage and the presence of uncomfortable and inconvenient bleacher seats made it less than satisfactory for this purpose. The library, the school's next-largest space, was also occasionally commandeered for large-group instruction and testing programs or for displays and exhibits, but it shared with the gym the drawback of being designed for quite another purpose. Moreover, each time the gym was used for a meeting or the library for testing, the school was at least temporarily deprived of a gym or a library. In short, the lack of auditorium-assembly space was effectively strait-jacketing the school's educational program.

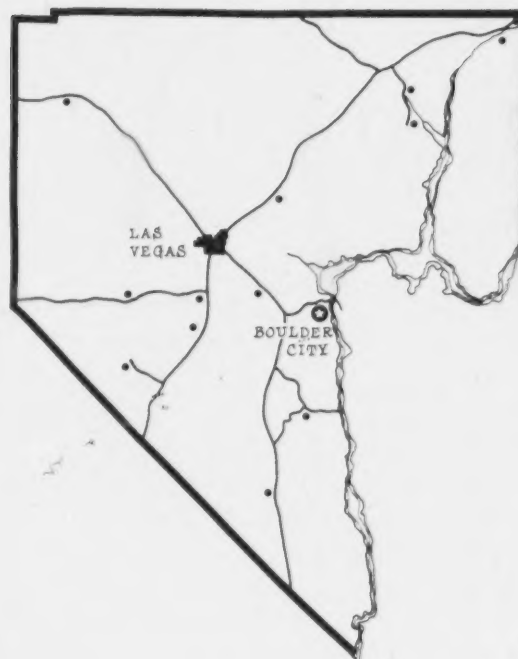
However, by the time the building which had been recommended to fill this demonstrable gap entered the detailed planning stage, the need for a watchful eye on the relationship between Boulder City and the federal government had proved equally clear. The possibility that the town might be released to local control had become a probability, raising the specter of a sudden population influx that could push school enrollments well over the yearly projections outlined in the master plan.

Boulder City was, in fact, emancipated in 1960, and while the school population has thus far stayed well within the predicted bounds, the availability of private home sites has already brought hints that the town might become a bedroom community for the booming industries nearby. Since the entire area is undergoing record expansion, it seems likely that, lacking its immunity as a government preserve, Boulder City and its schools will sooner rather than later have to absorb a greater share of Clark County's growing population.



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Toward a Full-Time Teaching Center

With this threat of a sharp enrollment increase in the offing, the consultants imported to develop detailed educational specifications for the proposed building faced a familiar dilemma. The potential need for more instructional space had to be reconciled with the existing need for an auditorium—which of all school facilities is probably the most notoriously under-utilized.

As the educational consultants pointed out, the traditional school auditorium provides a fixed seat for each member of the student body and the faculty, plus a few spare seats for guests. Once a week, a general assembly fills the seats for an hour or so. At other times, the speech and music departments use the stage for instruction, rehearsals, and presentations. Occasionally, when outdoor games are rained out, physical education classes file into the building for lectures on first aid or hygiene. On some evenings, the townspeople turn the auditorium into a meeting house or a concert hall.

All of these activities contribute to the over-all educational program. But all of them together put the auditorium to work only about 10 per cent of the time. This extremely low utilization of a relatively costly facility has made it more and more difficult for schools to find adequate educational or economic justification for the traditional auditorium, particularly in the face of present or pending classroom shortages.

Since the problem first came to a head in the years following World War II, the most frequent way out of the impasse has been to increase utilization and cut costs by lumping together in a single multi-use facility several activities requiring the assembly of large groups—that is, groups too big for the standard classroom. Hence the ubiquitous auditorium *cum* gymnasium *cum* cafeteria *cum* student commons *cum* town hall. But clearly this was no solution for Boulder City since it was precisely the school's dissatisfaction with makeshift assembly space that had generated the demand for an honest-to-goodness auditorium rather than some variation on the multi-use theme.

A more promising approach was to increase the utilization of the auditorium by increasing the frequency and volume of educational activities that could advantageously use its facilities. This second road around

the use-cost impasse has been smoothed considerably by the growing recognition of the educational and economic advantages to be gained by sacrificing the sacred cow of the 30-student classroom for a more flexible approach to the "right" size for a class. For example, the Trump Commission suggests that new material can be effectively presented to 100 to 150 students or more if the large-group presentations are combined with discussion and summation in small groups of 15 or so, and with independent study by individuals.

This, in turn, suggests that more use could be wrung from an auditorium if it were put to work as a classroom for large groups. However, the occasions on which a conventional auditorium could be used to administer worthwhile instruction to all of Boulder City's 7th to 12th graders in one dose would be few and far between. The occasions on which it could be used for teaching groups of 100 to 150 students would be much more frequent, but such groups would actually use only a small part of the auditorium's total capacity—and then only for short periods of time. Merely labeling a 500-seat auditorium a "large-group instruction space" cannot significantly increase its utilization.

The problem, then, was not only to give Boulder City High School a building that would meet both its immediate need for auditorium-assembly space and its imminent need for large-group instruction spaces suitable for teaching *à la* Trump, but also to build in a utilization factor high enough so that the building could act as a hedge against future bulges in enrollment.

The answer borrows a little from the traditional approach of multiplying the number of different activities for which an auditorium can be used, and a little more from the newer approach of multiplying the number of times it can be used for similar activities. Beginning with a conventional auditorium, the educational planners suggested that its efficiency be increased by using it as a large-group instruction space. Then they suggested that the efficiency of the large-group instruction space be increased by splitting it into smaller sections which could also be used for large-group instruction. Accordingly, their educational specifications sketch a wedge-shaped seating area which is divided first by an audiovisual core that bisects the wide end of the wedge, and then by two movable partitions that separate the rear

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alcoves on either side of the audio-visual core from the main seating area at the front of the auditorium.

By following this approach, Boulder City could have its cake and eat it too. With the partitions furled, the building would be a typical auditorium, complete with stage and all necessary public areas. With the partitions unfurled, it would become three independent teaching stations, each able to handle types of instruction for which the full auditorium would be too large, a standard classroom too small, and neither properly equipped. And if partitions could be found that would provide enough acoustic separation to permit the use of all three spaces at the same time, potential utilization could approach 100 per cent.

Increasing the use and usefulness of a space by making it divisible is not a new idea, but it is easier said than done. The effectiveness of a divided space rests on the effectiveness of the divider, and the effectiveness of the divider rests on requirements that are exacting and, to some extent, mutually exclusive. If the soundtrack of a film being shown in one section of a divisible room drowns out a lecture in the space next door, and vice versa, neither space is an educational asset. So the divider between them must block sound. If shifting the divider requires a trained crew or a great deal of time or effort, it simply won't be shifted, and the room will be divisible only in theory. So the divider must be easy to move.

Unfortunately, the simplest way to make a partition soundproof is to make it heavy — which also makes it difficult to move. Reconciling these contradictory qualities has long been technically feasible, but seldom at a feasible price. So while the concept of a divisible auditorium was simple, workable, and wholly acceptable to Boulder City and the Clark County administrative unit, the success of the proposal rested squarely on the question of whether partitions could be found that would provide the required mobility and noise reduction without fracturing the building budget.

Design for Divisibility

The building that emerged as the proposal moved from the conference table to the drawing boards of architects Zick and Sharp is essentially an elaboration

The architects' translation of the educational specifications for the Boulder City auditorium is a wedge-shaped building with public areas, including generous lobby and display space, at the wide end, and a stage at the narrow end. Soundproof operable partitions automatically divide the central seating area into three independent spaces suitable for large group instruction

of the basic scheme proposed by the educational planners. The wedge-shaped auditorium is fronted by a broad curving portico that merges into an outdoor lobby from which one enters a wide corridor extending the full width of the building. In addition to providing generous circulation space, this corridor serves as a gallery where art, science, and other exhibits of interest to students and visitors can be effectively shown, thus meeting the school's need for an exhibit area in which neither the displays nor their viewers interfere with other activities allotted to the space. (The library was formerly the school's principal showcase for displays.)

Four steps down from the center of the gallery is a small lobby which serves as the main entrance to the auditorium seating area. The audio-visual control center is located directly over the lobby, and entered via short flights of stairs that climb its side walls. Since the two-story core formed by the lobby and overhead audio-visual room projects into the middle of the auditorium, it carves the seating area within into a rough U-shape.

The strokes of the U are two 105-seat alcoves flanking the central core; the base of the U is the forward seating section of the auditorium. Between the stage and the 220-seat front section is a flat stretch of floor which is large enough to accommodate the 70 portable chairs needed to bring the auditorium up to its full 500-seat capacity. This flat floor area is also used as an arena for informal student activities ranging from pep rallies to after-school dances, and on occasion, as an orchestra pit.

The stage itself is first cousin to the standard proscenium stage found in any typical high school auditorium. It certainly makes no contribution to theater technology, but it is adequately equipped for the theatrical demands likely to be made on it, and it provides a laboratory-workshop for instruction and prac-



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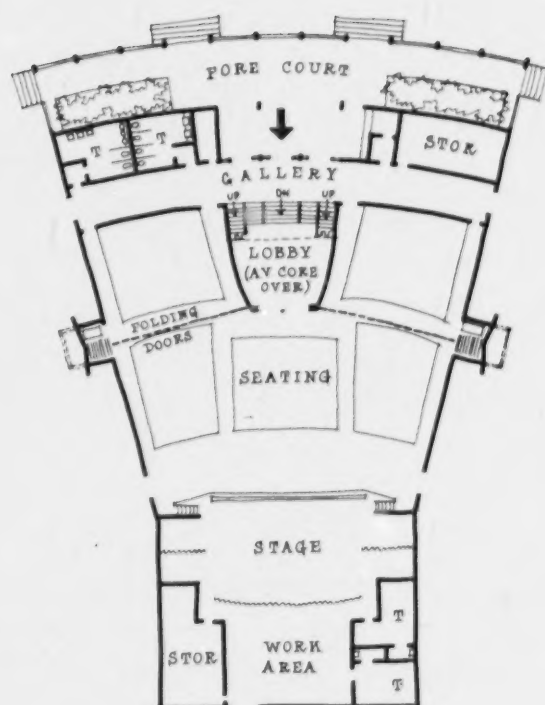
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tice in stagecraft. In fact, with both the stage and the audio-visual workshop, the auditorium offers facilities for exploratory, and to some degree terminal, vocational training in communications technology, lighting, and stage management — skills that are of practical value in a community only 30 miles from Las Vegas, where entertainment is big business and the twice-nightly show an important part of the casino's stock in trade.

Thus the building does everything expected of it as an auditorium — and perhaps a little more, thanks to the built-in gallery and the audio-visual workshop. The first step toward making it work equally well as an instruction center was taken when the core enclosing the lobby and audio-visual room was placed at the hub of the seating area, where it physically defines the three teaching sub-sections within the total space: the broad seating area in front of the core, and the smaller seating areas on either side of it.

Although the rear alcoves flanking the core are an integral part of the auditorium — even the corner seats in the back rows give a full view of the stage — they are also enclosed on three sides by permanent walls, and, therefore, are three-quarters along the way to being independent teaching areas. All that is needed to break the remaining link with the rest of the auditorium is a fourth wall.

So the second step toward converting the auditorium into a full-time instruction center was to complete the physical separation between the three roughly defined subdivisions by providing fourth walls that could be quickly drawn across the front of the alcoves to give them the visual and acoustic privacy of completely enclosed lecture halls. Since acoustic privacy was the biggest hurdle, acoustical consultants Bolt Beranek and Newman were brought in, with some assistance from EFL, to guide the architects in spelling out realistic requirements for the operable walls, and in planning other aspects of the building so as to give the walls as sympathetic an acoustic environment as possible.

The efficiency of any wall as a sound barrier is measured by how much it reduces the intensity of sounds of various frequencies (or pitches) as they travel through it. Since most of the contemplated activities on either side of the acoustic barriers dividing Boulder City's

instruction center were to involve only speech, the operable walls there could be designed primarily to filter sounds in the relatively limited frequency range embraced by the human speaking voice.

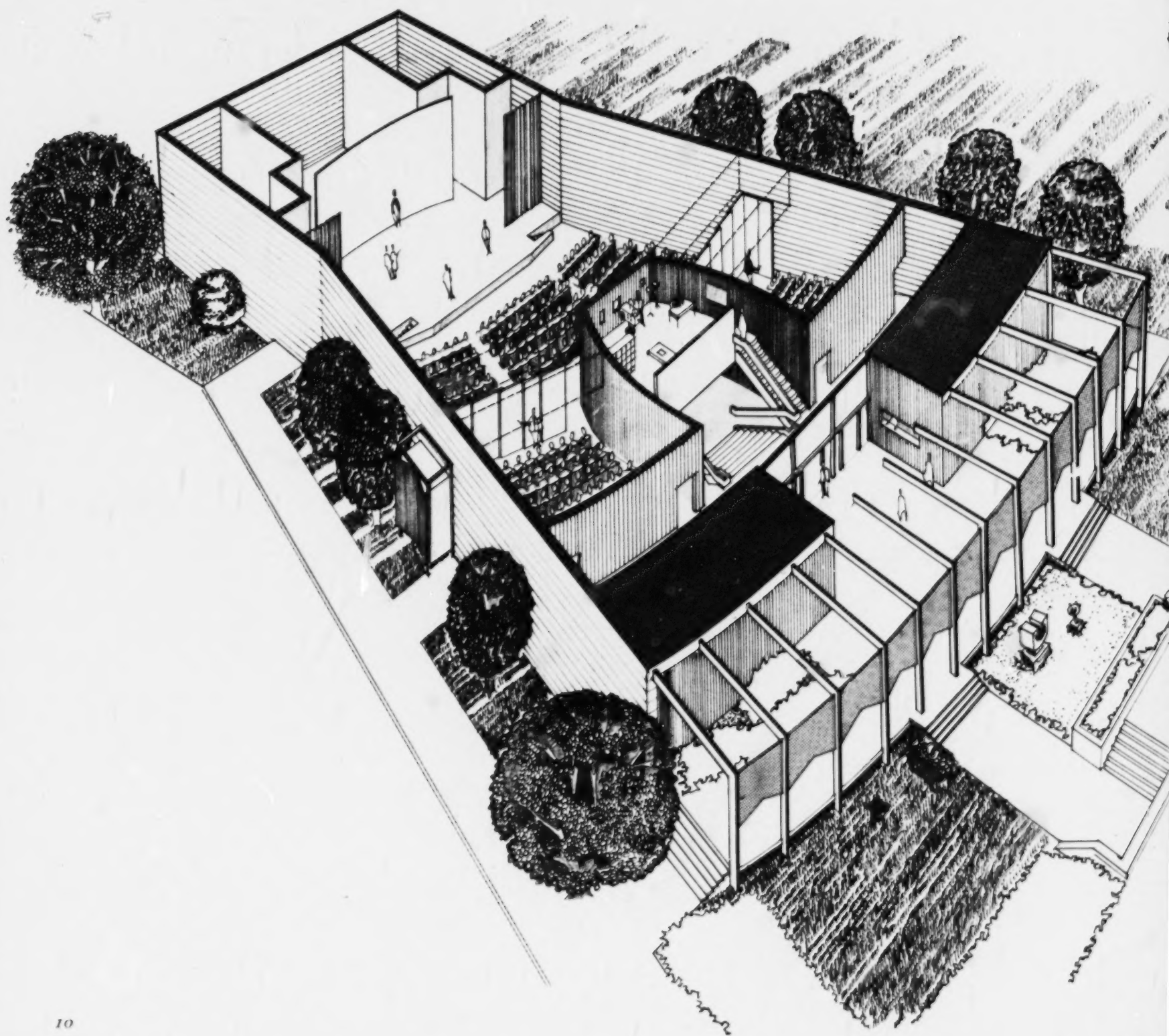
To be sure, the auditorium as a whole will occasionally be used for music performances, and the subdivisions are often used to show films whose soundtracks include background music. But it was felt that the simultaneous presence of music and speech in adjacent spaces would not be frequent enough or of long enough duration to justify the extra cost of walls capable of meeting the more stringent requirements for isolating music.

The sound reducing burden placed on the operable walls could also be lightened by harnessing the ability of one sound to mask out other sounds which have about the same intensity and frequency. Because a high background noise level can blot out stray snatches of unwanted sound as effectively as a strong perfume might soak up stray whiffs of onion, masking noise can be used as "acoustical perfume." The more perfume is introduced to cover up speech sounds leaking from one side of an acoustic barrier to the other, the less sound the barrier itself must filter out in order to provide effective isolation.

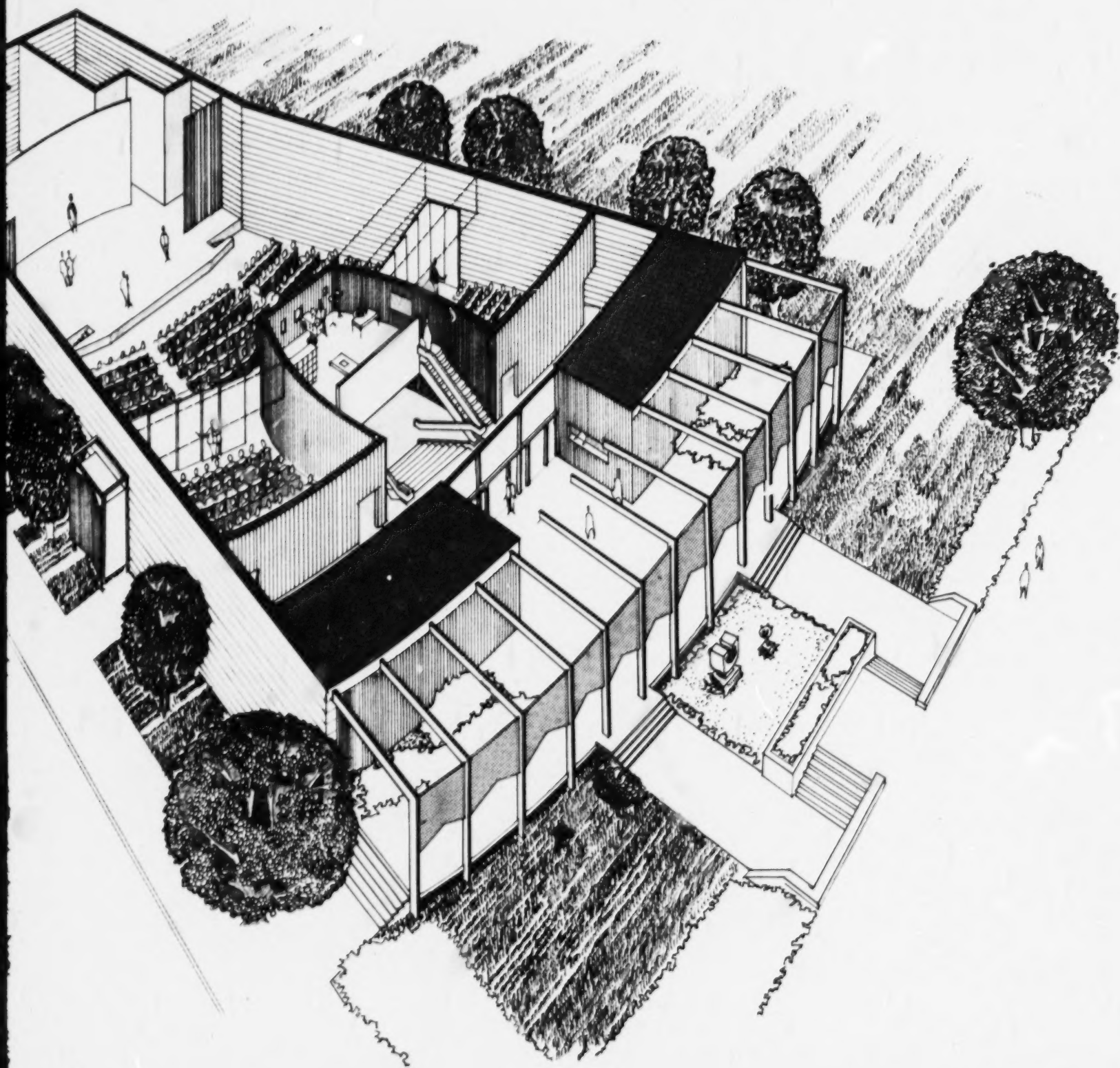
In the case of Boulder City's auditorium, the perfume, or more precisely the ambient sound, could be introduced through the year-round air conditioning system. The trick was to keep the constant hum from the air distribution devices at a level high enough to blur any unwanted speech sounds that chanced to slip through the partitions between subdivisions, but low enough not to interfere with the intelligibility of sounds originating within the subdivisions themselves. The masking noise also had to be kept at a level that would permit speech emanating from the stage to be heard clearly from the back rows of the opened auditorium.

This last restriction, however, could be eased by using the amplifying system provided for reproducing canned sound — film soundtracks, recordings, and broadcasts — to reinforce the voices of speakers when necessary. So the air conditioning system could be planned to produce an ambient sound level high enough so that the noise reduction specifications for the oper-

SECTION 1



SECTION 2



able walls could be relaxed slightly — thus reducing the cost of the walls — without relaxing the over-all requirements for acoustic privacy between the auditorium's subdivisions.

Found: A Divider That Works

Even with these built-in assists from the relative infrequency of coexistent music and speech, and from the masking murmur of the air conditioning, the acoustic standards set up for the subdividing partitions were high. The acoustical consultants suggested that the walls should provide minimum sound reductions ranging from 29 decibels at the low end of the critical frequency spectrum to 35 decibels at the high end; and the architects later not only upped these sound reduction requirements to specified minimums of 40 and 50 decibels, but also increased the spread of the frequency range deemed critical for speech isolation. Freely translated, the final specification demanded that walls light enough to be easily movable provide as much acoustic privacy as solid 4-inch brick walls weighing 40 pounds per square foot.

The operable partitions chosen to fill this bill are king-size folding doors suspended from overhead tracks that stretch across the openings of the two rear alcoves. The doors are made up of 3-inch thick rigid panels, each 4 feet wide by 14 feet 4 inches tall, which are joined by continuous hinges similar to those used on pianos. When the partitions are open, they nest in special outside pockets which were provided to prevent the thick bundles formed by the stacked panels from jut-

ting into the side aisles of the auditorium.

To convert one of the alcoves into a self-sufficient lecture hall takes two minutes. The completely automatic operation is triggered by turning a key in a tiny control panel mounted on the face of the lobby core. The key, which starts the small electric motor that drives the door along its overhead track, is held in the "close" position while the door moves out of its pocket and snakes across the opening to butt against the core wall. When the partition is fully extended, a limit switch automatically cuts off the drive motor and starts up the pneumatic system that seals the door in place.

The same process in reverse retracts the door and opens the lecture room to the rest of the auditorium. The control key is turned to "open;" the pneumatic seals are released; and the motor-driven pulley draws the panels back in a series of accordion folds until the door is tucked neatly away in the waiting pocket.

Since a void stops no sound at all, even a tiny crack in a wall can permit a seemingly disproportionate amount of noise to leak through. And since a movable wall is by definition surrounded by a continuous crack, the efficiency with which the wall is sealed can make or break it as an acoustic barrier. The pneumatic sealing system that makes the operable wall installation at Boulder City relies on a series of inflatable gaskets to provide an airtight pressure seal around the doors.

The horizontal joints at top and bottom of each door are sealed by an inflatable gasket which is buried in a floor trench and covered by a flush metal plate. When the door is closed and the pneumatic sealing operation begins, the gasket swells so that it lifts the metal plate through the gap which was left between floor and door to permit the panels to move freely along the track. The increasing pressure of the gasket against the plate then pushes the entire door upward until a similar gap above the panels is also closed, and the resilient strips of neoprene rubber which are mounted on the bottom edges of the panels and the lower edge of the ceiling track are compressed enough to ensure a tight seal.

The gaskets at each side of the door opening are housed in a vertical channel and capped by an unobtrusive strip of neoprene rubber set flush with the wall. As air is pumped into the hollow gaskets after the door

Because Boulder City's new facility can be divided at will and at once, it lends itself to types of instruction for which a standard auditorium would be too large, a standard classroom too small. The partial subdivision created by a permanent split-level core with audio-visual workshop above and lobby below is completed by the operable walls, which block sound so effectively that all three subdivisions can be used at the same time. The resulting flexibility boosts the utilization of the building from the 10 per cent usual for a high school auditorium to a potential approaching 100 per cent

is in position, the gaskets inflate, squeezing the resilient neoprene against the edges of the end panels.

Sound leakage through the vertical seams between panels is blocked by backing each hinge with a continuous strip of neoprene which is firmly clamped to the edges of the adjacent panels. While the panels are stacked for storage, these neoprene strips fold out to form smooth, rounded hinge covers. But as the door begins to close, the flexible strips pleat themselves into M-shaped gaskets, which the panels pinch together until the gaskets are compressed enough to provide the necessary acoustic seal at the inter-panel joints.

Because this pressure sealing system prevents noise from leaking around the panels, the performance of the operable walls can ultimately be measured by how much noise leaks through the panels. The panels themselves were specially constructed to provide the required degree of sound reduction without exceeding the weight limit imposed by the need for fast, economical operation. Each consists of a steel frame wrapped around a multi-layered sandwich whose ingredients include, reading from back to front of the auditorium: vinyl coated steel, sheet rock, acoustic filler, more sheet rock, another sheet of steel, another layer of acoustic filler, and finally, perforated enameled steel.

This final layer of perforated metal backed by an acoustic blanket absorbs sound emanating from the stage, and thus improves speech intelligibility by swallowing the disturbing echoes that would bounce off a more reflective surface. The same function is performed by similar sound-absorbing finishes on the permanent walls facing the stage — the back walls of the alcoves and the front wall of the lobby-audio-visual core.

Other interior features of the building were also chosen with an eye — or more properly, an ear — on acoustics. For example, the hard plaster finish and irregular profile of the ceiling over the seating area produce maximum sound levels in the back rows of the opened auditorium by reinforcing sounds from the stage, while the acoustic-tiled ceilings in the lobby and gallery, and over the rear of the stage itself, prevent a similar dispersion of sound from these areas. To make sure that sound projected from the stage maintains clarity as it travels through the auditorium, the acoustical consultants also recommended carpeted

floors and upholstered seats, which would supplement the reverberation control provided by the sound absorptive surfaces facing the stage. (Carpeting has been installed since the completion of the building, but the tight budget made it necessary to rely on the sitters to sound cushion the seats.)

Thanks to this painstaking attention to the acoustic design of the operable walls themselves and the various building elements that could help or hinder their work, the walls stop sound so effectively that visitors testing them by ear have been known to think themselves the victims of a hoax. When one enters the front portion of the divided auditorium to be assaulted by music blaring full blast from the powerful loudspeaker system, and hurriedly retreats to one of the rear lecture halls to hear — nothing, it is hard to believe that someone hasn't stopped the music. Someone hasn't. A keen ear pressed against one of the seams in the partition can pick up a faint musical murmur from the other side. But from a foot or so away from the partition, even the keenest ear can pick up no sound at all — although the partition was intended to obliterate soliloquys, not symphonies.

The objective sound measurements taken by Bolt Beranek and Newman (See Appendix, page 20) confirm the results of such informal listening tests. While the amount of sound blocked by the partitions varies over the critical frequency range — and indeed varies from wall to wall, and from front to back of the same wall — the average noise reduction is about 40 decibels. This means that the operable walls, which weigh only about 10 pounds per square foot, match the performance of the hefty brick wall taken as a model.

A Pebble in the Pond

The importance of Boulder City High School's new divisible instruction center can be summed up in two words. It works.

Because it proves that the acoustical and mechanical problems posed by divisibility can be overcome, it dropped into the educational pond with a splash that spread ripples from Connecticut to California, leaving in their wake a whole company of similar structures in various stages of planning and execution.

As a model for schools bent on exploring the benefits to be reaped from multiplying space by dividing it, the facility's principal flaw is that much of its potential is as yet unexploited. Since the existing high school has, at least for the moment, enough space and staff for its ordinary instructional needs, there has been little pressure to take advantage of the extra teaching space that could be provided by full time use of the auditorium. Nor has there been much pressure for experimentation with the new teaching techniques for which the building's large spaces are best suited. Until enrollments increase enough to demand it, a full-scale test of the use that might be wrung from the building if the curriculum and class schedule were tailored to it is not likely to be made.

In the meantime, though, as the principal's summary of proposed uses for the building (below) clearly shows, the new auditorium, with its badly needed stage, and assembly spaces, and audio-visual equipment, is being used fully within the limits of the present enrollment and educational program. Later on, when the student body is larger and the program is modified, the facility will provide enough space for the school to grow in and enough adaptability to respond readily to new educational needs.

For Boulder City, the building works now and will continue to do so through the foreseeable future. For schools everywhere, it offers tangible proof that divisible space can be not only educationally desirable, but technically and economically feasible.

Specific Uses of Divisible Auditorium / Boulder City High School

FUNCTION	TECHNIQUES
Music instruction: choral groups, instrumental groups	Rehearsals, use of recordings for follow-up instruction, performances
Dramatic, public speaking and assembly program groups	Rehearsals, performances
Class and other large group meetings	
Large group testing programs	
Large group instruction	Career lectures and guidance, team teaching techniques as student body and staff grow to justify
Display purposes	Art exhibits, science fairs
Visual and auditory aids	Movie projection for classes, other visual aids demonstrations
Organization and direction of students as service groups and student aids for teachers	Operation of projectors, sound amplification operation, tape recording, sound reproduction, stage lighting control
Laboratory studies in electronic sound control, amplification and recording techniques, studies in maintenance of equipment, studies in stage management and lighting control	Student trainees
Future development of closed circuit television	
Community uses	In accordance with school district policy



SECTION 1



2.

1. A curving portico along the City auditorium merges into a space where the box office and other functions are located. Exposed columns and a large glass panel stand out in candy-striped patterns against the front wall of the building. A sun screen shades the portico.

2. From the main entrance, a corridor that doubles as a gallery for 'tween-acts circulation leads to the audio-visual room. The corridor opens into the front section of the auditorium.

3. The focal point of the auditorium is the stage, which can be seen clearly from every angle. It is frequently used for assemblies, lectures and demonstration community gatherings, as well as for performances, rehearsals, and other events.



SECTION 2



2.

1. A curving portico along the front of the Boulder City auditorium merges into a forecourt (left in photo) where the box office and main entrance are located. Exposed columns and beams painted in bright red stand out in candy-stripe contrast against the white front wall of the building. A gold-painted aluminum sun screen shades the portico from desert sun and glare

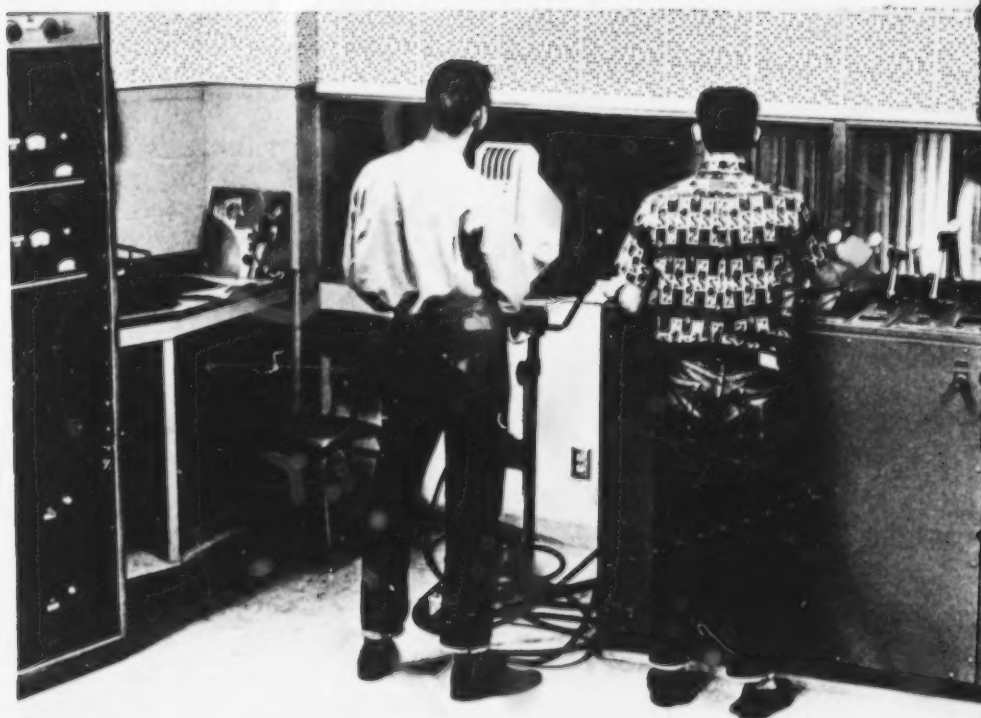
2. From the main entrance, one enters a broad corridor that doubles as a gallery for displays and a lobby for 'tween-acts circulation. The stairs at right lead up to the audio-visual room, down to a small lobby which opens into the front section of the auditorium

3. The focal point of the auditorium, the stage, can be seen clearly from every seat in the house. It is used frequently during assembly programs, large group lectures and demonstrations, and other school and community gatherings, as well as for musical and dramatic performances, rehearsals, and instruction



3.

SECTION 1



4.



5.



6.

SECTION 2



4.

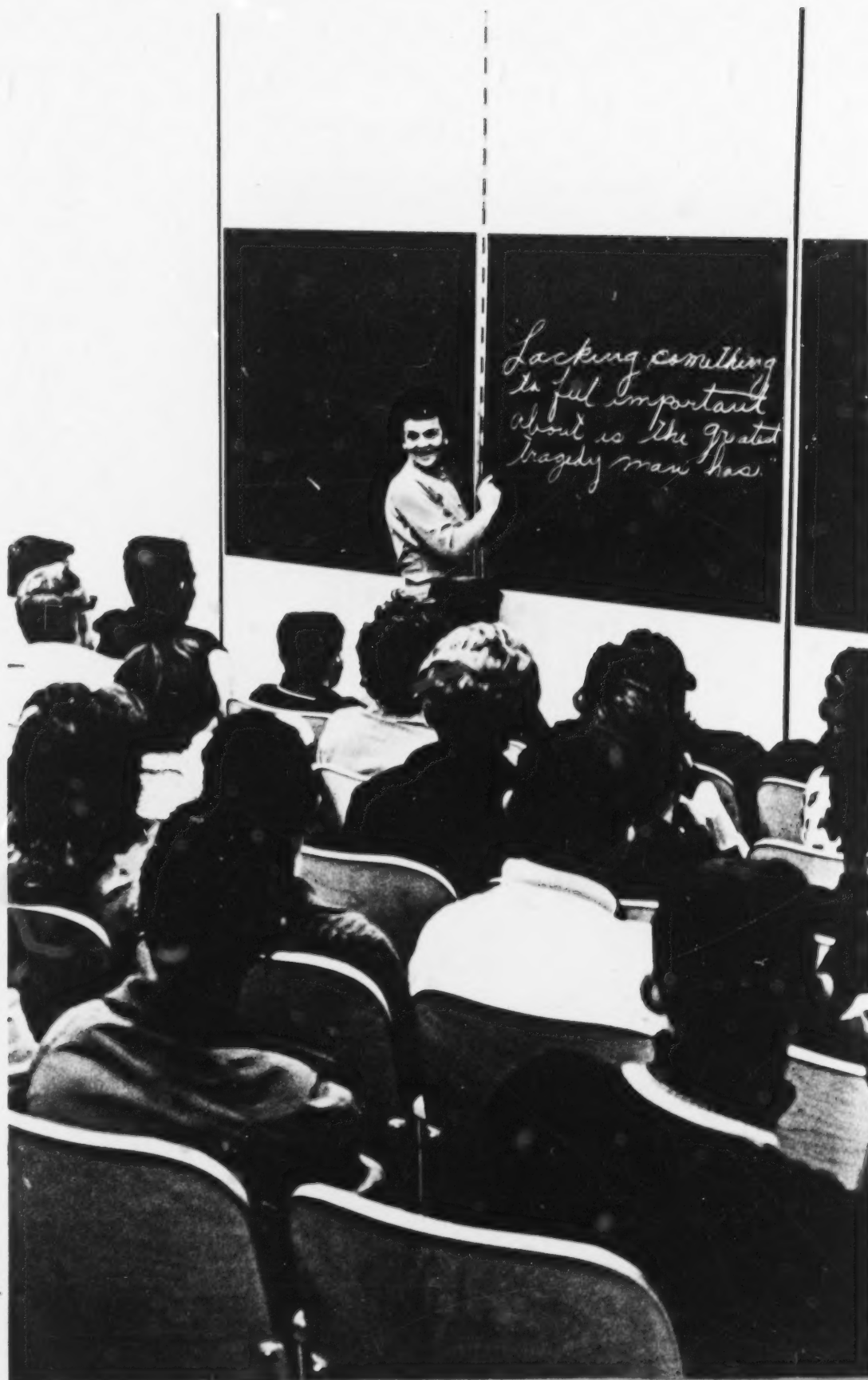


5.

6.



SECTION 1



4. Stage and house lights and amplification are contained in the visual room. The light projection port facing the stage is for the three auditorium screens. The stage wall (left in photo) is a workshop for preparing the classroom for informal instruction and communications technology.

5. With the movable partition, the auditorium seating area can be reconfigured for various purposes. The flat floor area (foreground in photo) is used for informal student activities and for portable chairs that can be moved in and out of the room and it does occasional dance.

6. and 7. With the folding walls, the U becomes a self-contained space; the rear alcoves (C) are small halls that seat up to three people for lectures, audio-visual presentations, group instruction. The space is frequently used for after-school activities, community organizations. Students can move directly into the front screen area or directly into the rear alcove area independent of the other areas. The operable walls, which can be moved to or from adjoining spaces.

SECTION 2



4. Stage and house lighting, and sound reproduction and amplification are controlled from the central audio-visual room. The lighting console is below an observation port facing the stage; the sound system controls for the three auditorium subdivisions are banked along one wall (left in photo). The room also serves as a workshop for preparing audio-visual aids, and as a classroom for informal instruction and practice in stage and communications technology

5. With the movable partitions open, the U-shaped auditorium seating area accommodates up to 500 persons. The flat floor area directly in front of the stage (foreground in photo) usually serves as an arena for informal student activities, but it also provides space for portable chairs that supplement the fixed seating, and it does occasional duty as an orchestra pit

6. and 7. With the folding doors closed, the base of the U becomes a self-contained instruction-assembly space; the rear alcoves (7) become sound-sealed lecture halls that seat up to three 30-student classes for special lectures, audio-visual programs, and other types of large group instruction. The three spaces are also used frequently for after-school meetings of school and community organizations. Since the central lobby opens directly into the front section, while the gallery opens directly into the rear alcoves, each space is physically independent of the others. Acoustic privacy is assured by the operable walls, which prevent sound's traveling to or from adjoining spaces

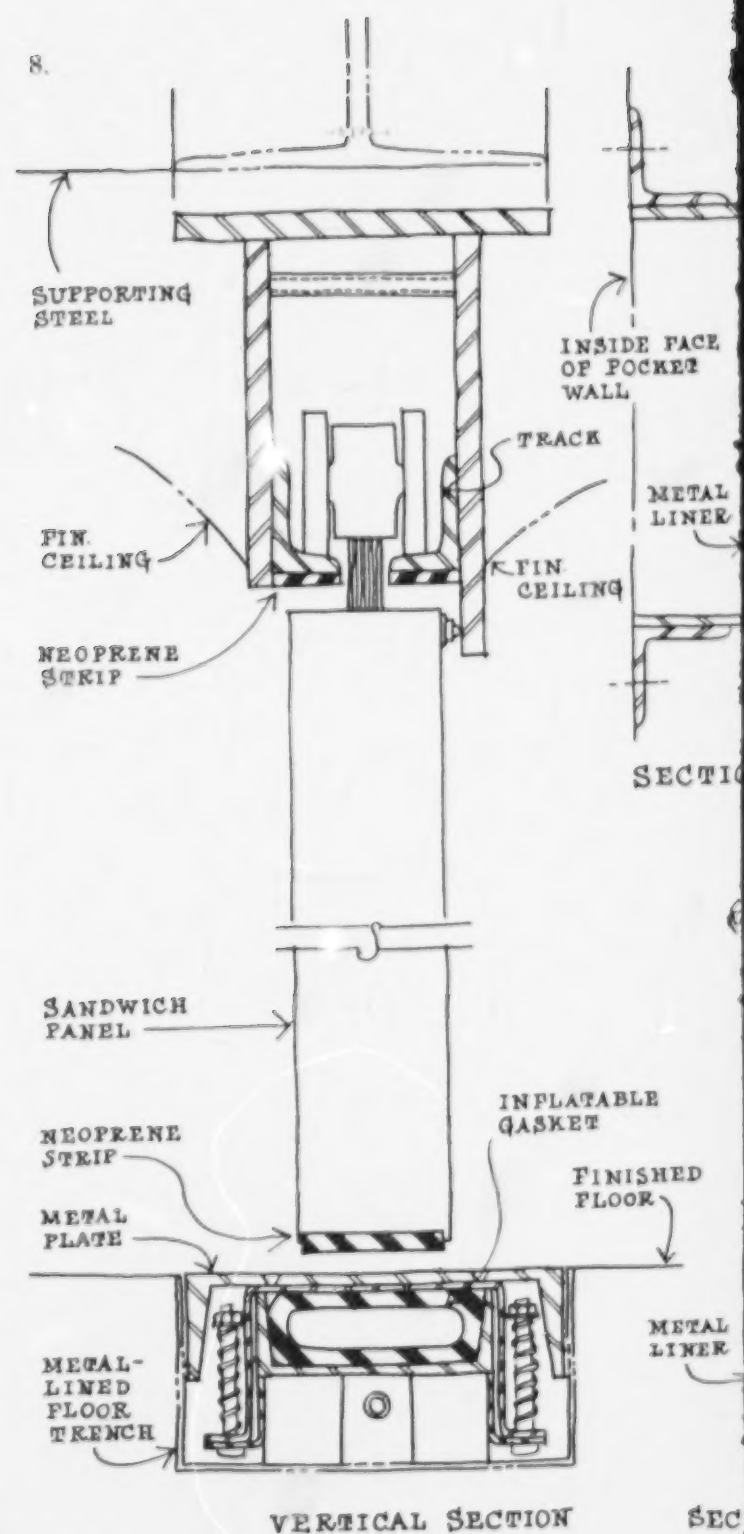
SECTION 1

8. The vertical section shows how the folding doors are sealed at top and bottom. When the door is fully closed, the gasket in the floor trench inflates automatically, pushing the metal cap against the neoprene strip on the bottom of the door. Pneumatic pressure then raises the entire door to meet a similar neoprene strip on the underside of the ceiling track, thus completing the airtight seal. The horizontal sections at right show the channels at the pocket and lobby walls. The inflatable gaskets housed in these channels force neoprene caps against the panels at both ends of the doors, creating enough sidewise pressure to seal the rubber-gasketed seams between the panels as well as the cracks where the panels meet the walls

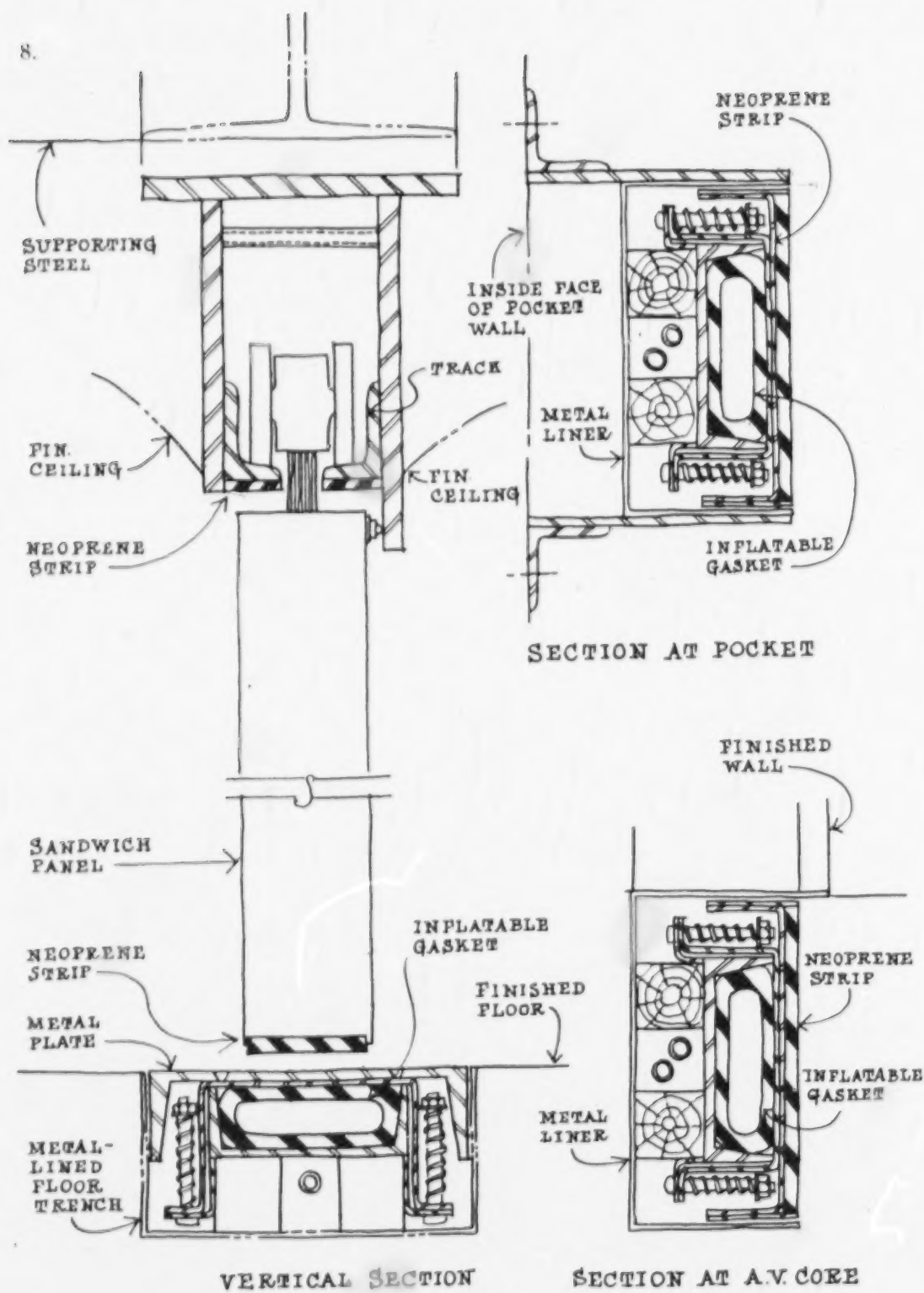
9. When the door is completely retracted, its panels nest flat against the pocket wall, concealed by a door that slides across the pocket opening. Because the pocket juts out from the side wall of the building, the stacked panels take no interior floor space, and the side aisle is kept clear for circulation

10. Turning a key in a control panel on the face of the lobby wall activates a mechanism that first draws the folding door across the front of the alcove, then inflates the pressure seal. The same operation in reverse is used to pull the door back to nest in the pocket. In either direction, the operation takes just two minutes

11. The special pockets used to store the folding doors are treated as decorative exterior elements. The red-painted exposed steel framework and the white pocket wall pick up the candy-stripe colors of the portico; the exterior walls of the auditorium itself are painted green on one side of the building, yellow on the other



SECTION 2



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SECTION 1



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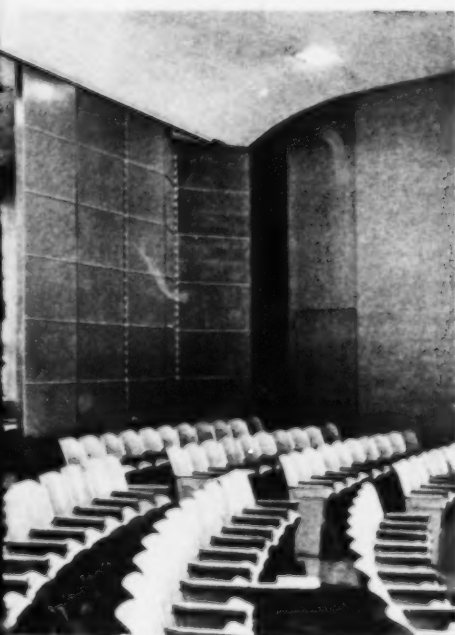
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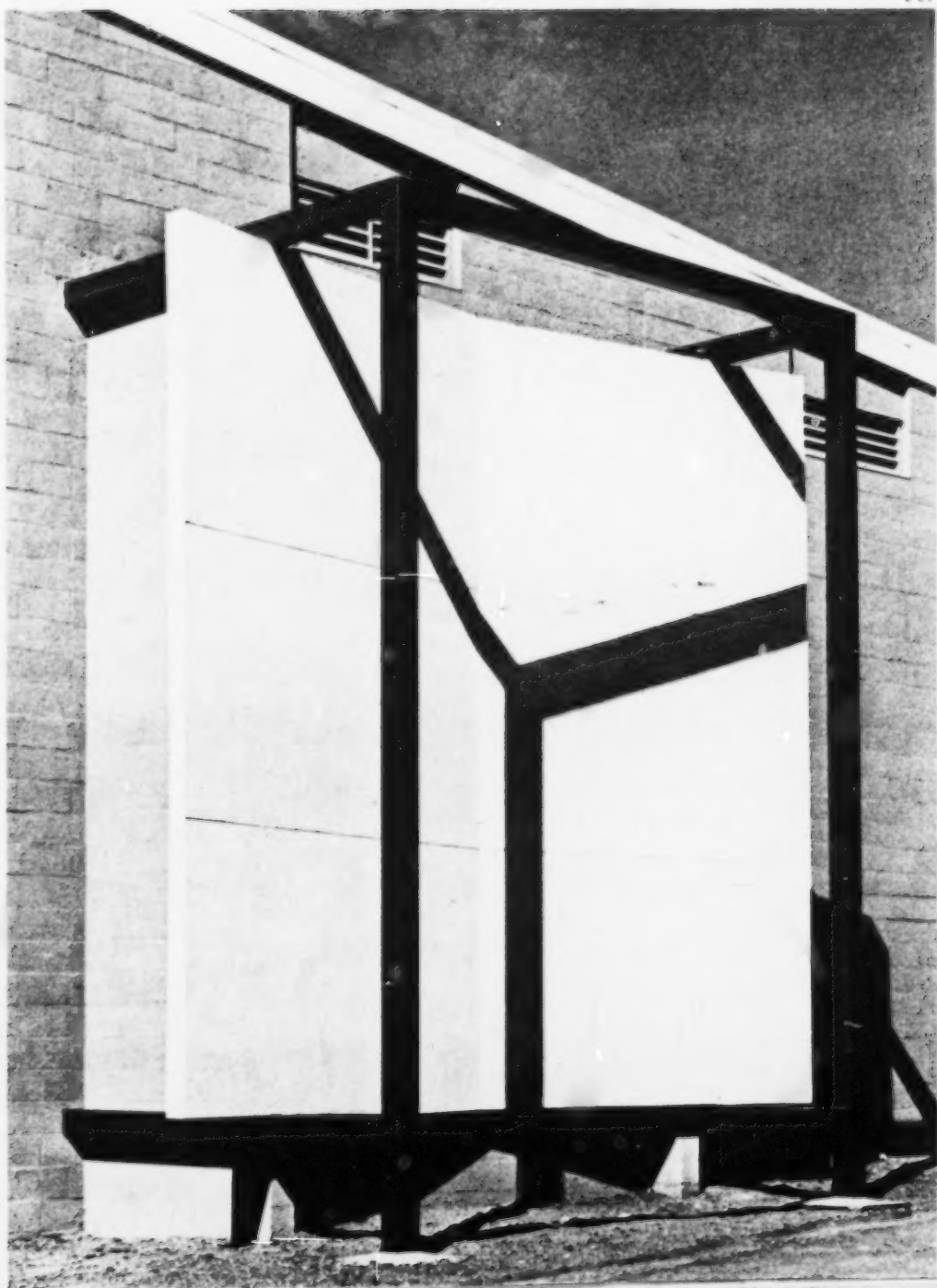
SECTION 2



9.



10.



11.

APPENDIX

Educational Facilities Laboratories, Inc.
477 Madison Avenue
New York 22, New York

Subject: Multi-Use Instruction Center, Boulder City,
Nevada

Gentlemen:

We are enclosing prints of our Figures 1 through 4, showing the results of the sound isolation measurements made in the new Multi-Use Instructional Center in Boulder City, Nevada, on 3 and 4 January 1962.

Figure 1 shows the measured noise reduction provided by the partition to the east classroom. Notice that due to the different amounts of absorption [on opposite sides of the partition] there is better isolation in one direction than in the other. In the case of the east door, only the transmission from the large room to the classroom was actually measured.

Figure 2 shows the noise reduction both ways

through the west door. Comparing the corresponding curves on Figures 1 and 2, there is good agreement in the mid frequencies and an indication that the west door provides less isolation than the east door at high and low frequencies. In the low frequencies, I assume this to be experimental error. At the high frequencies, I may have been flanked by sound traveling mainly through the door pocket.

Figure 3 shows the averages of the ambient levels in each octave band, measured in nine positions around the room, with the air conditioning system operating...

The conclusions I draw from Figures 1 through 3 are in precise agreement with our subjective observations. In other words, the combination of high sound isolation provided by the partition and a moderately high ambient noise level result in an extremely effective division of the three spaces. In all probability, the ambient could be dropped by 5 decibels without seriously compromising the effectiveness of the installation. In particular, I would like to see the ambient sound in the frequency range from 150 to 600 cycles per second



SECTION 1

Figure 1

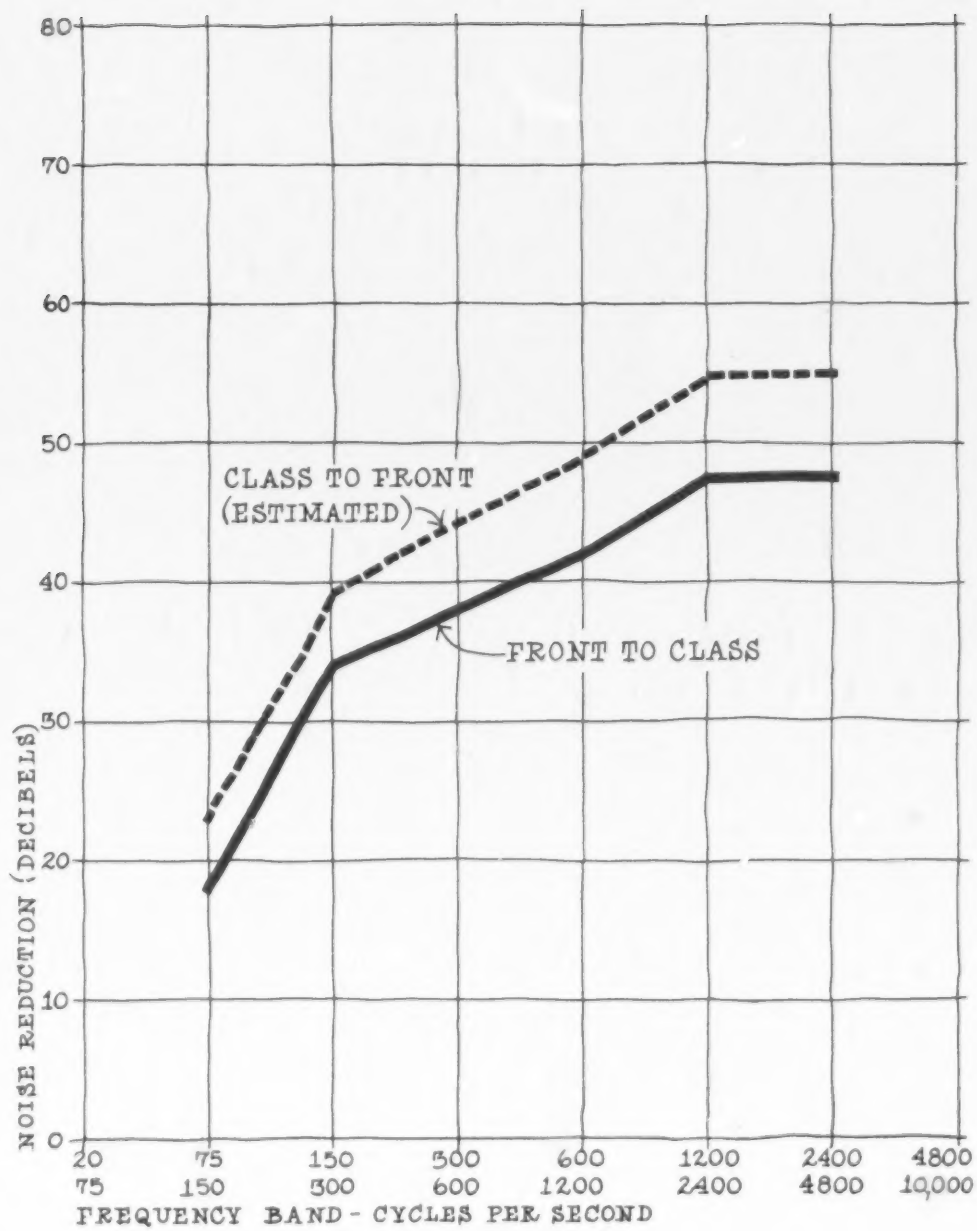
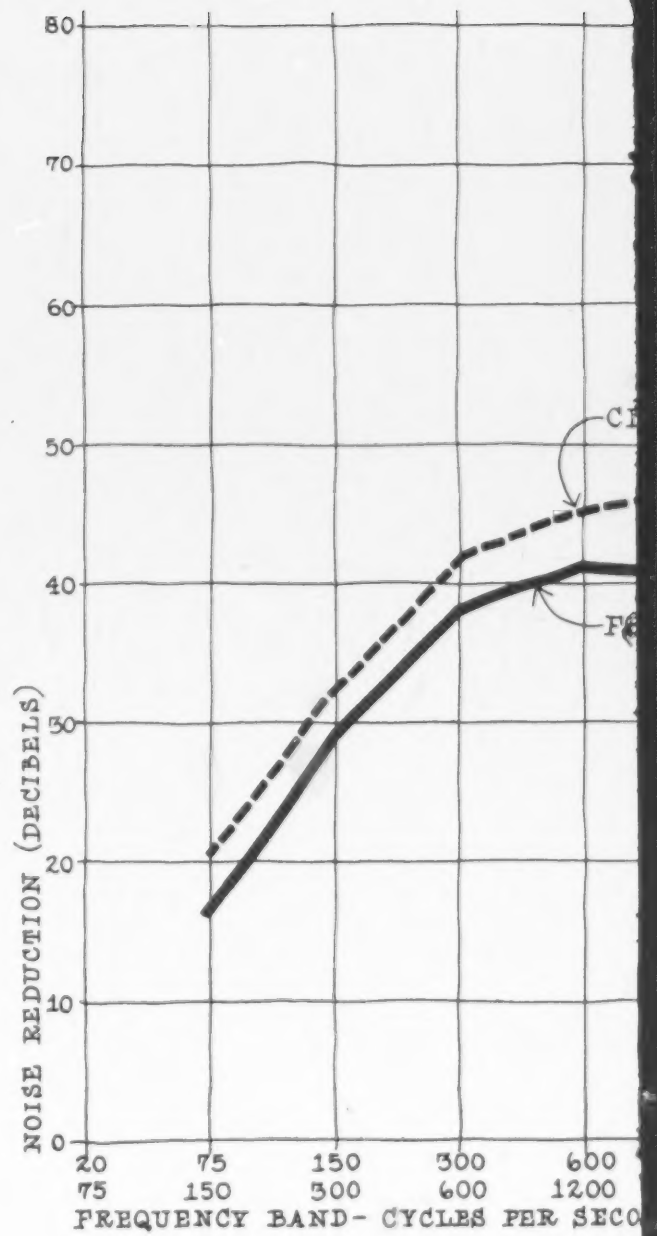
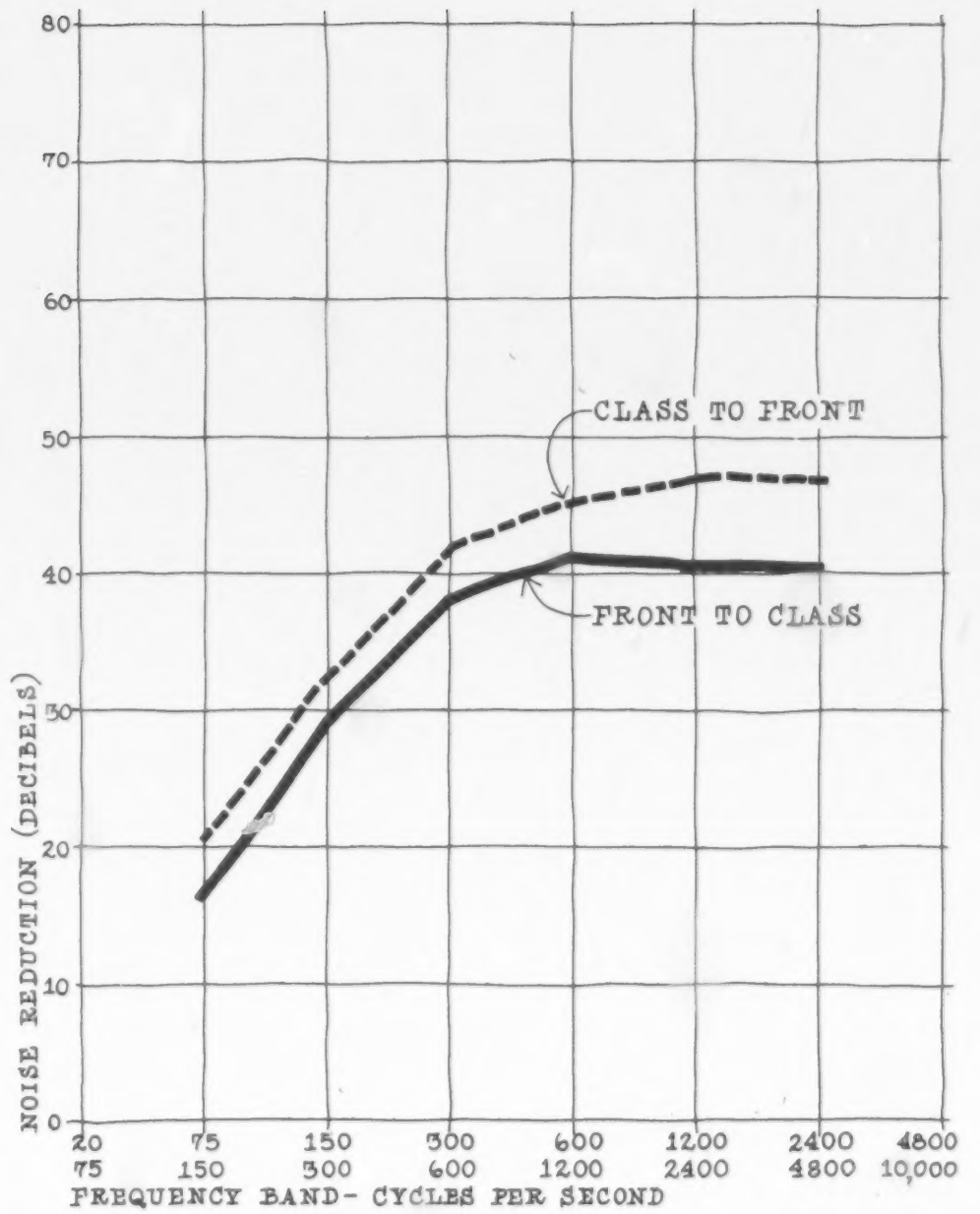
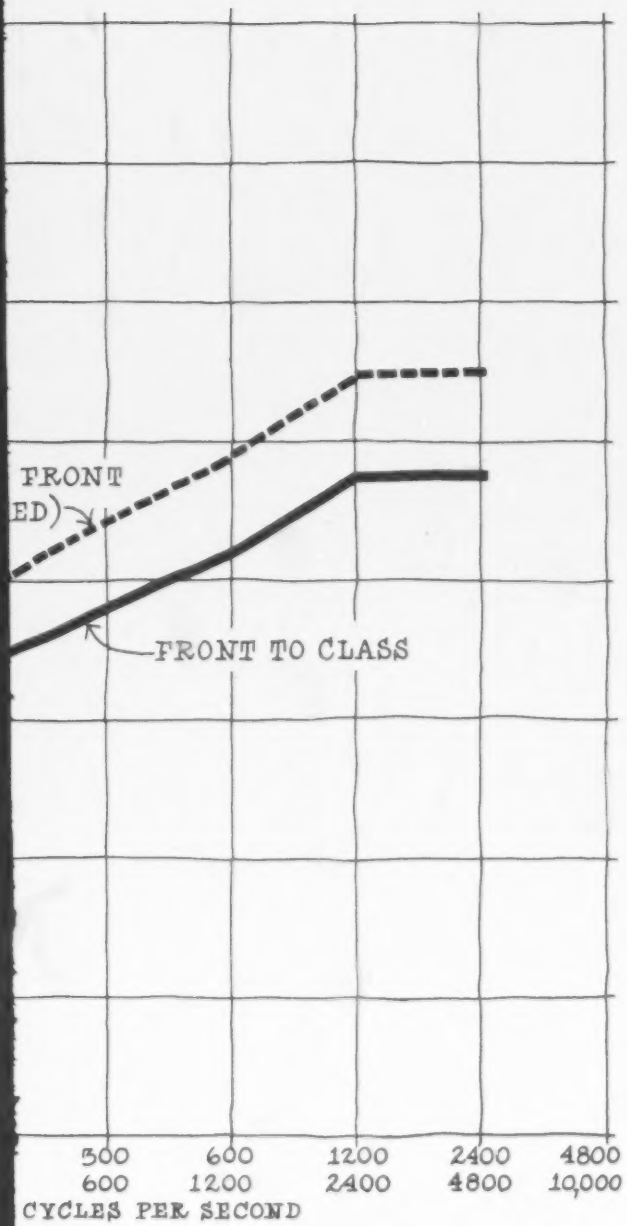


Figure 2



SECTION 2

Figure 2



SECTION 1

Figure 3

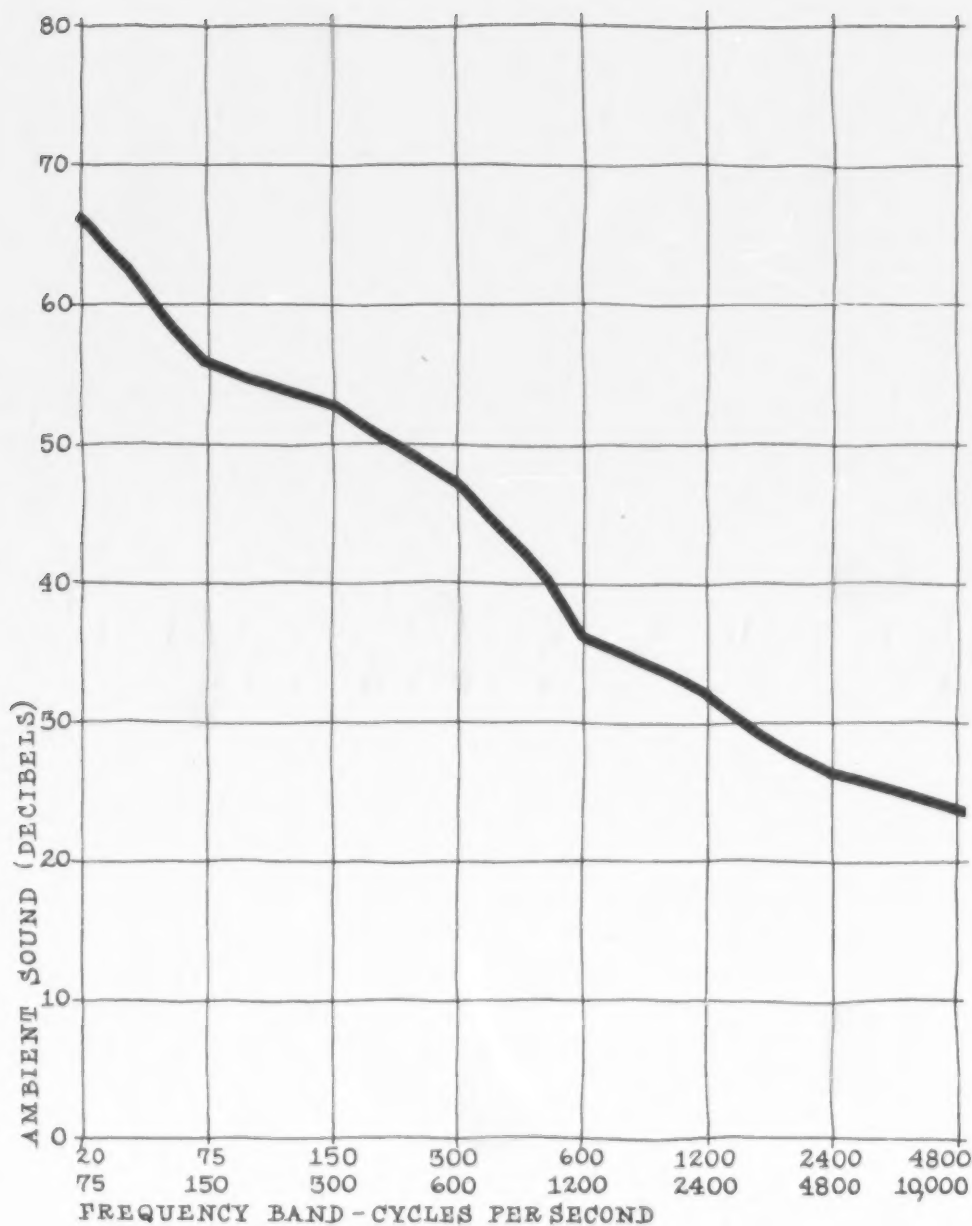
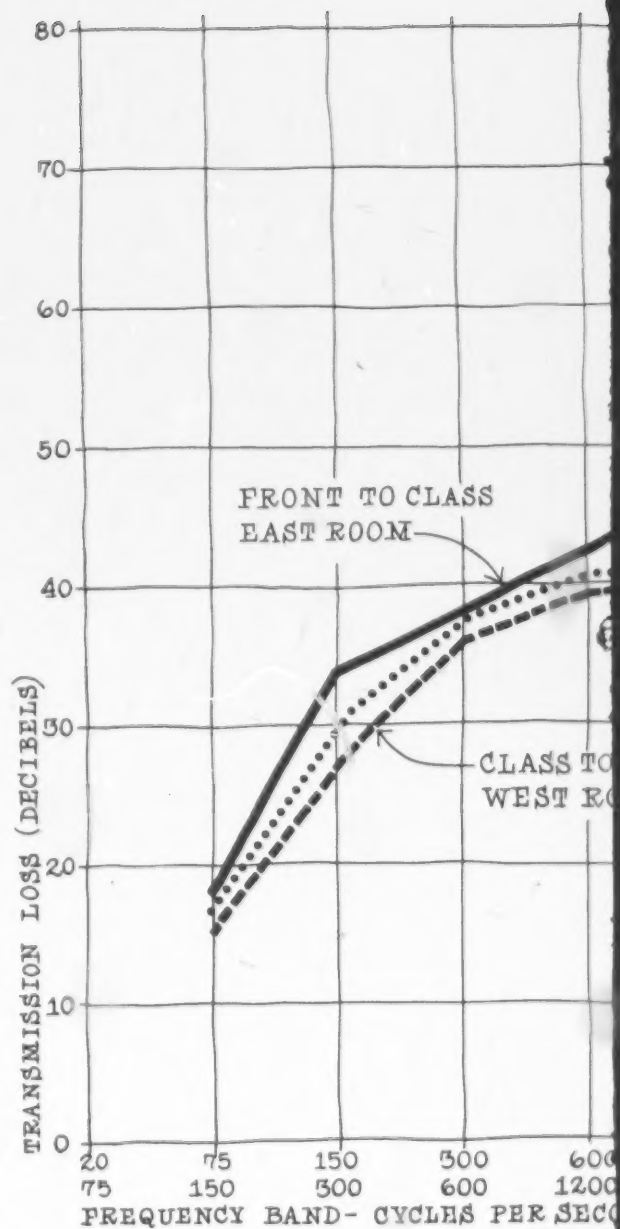
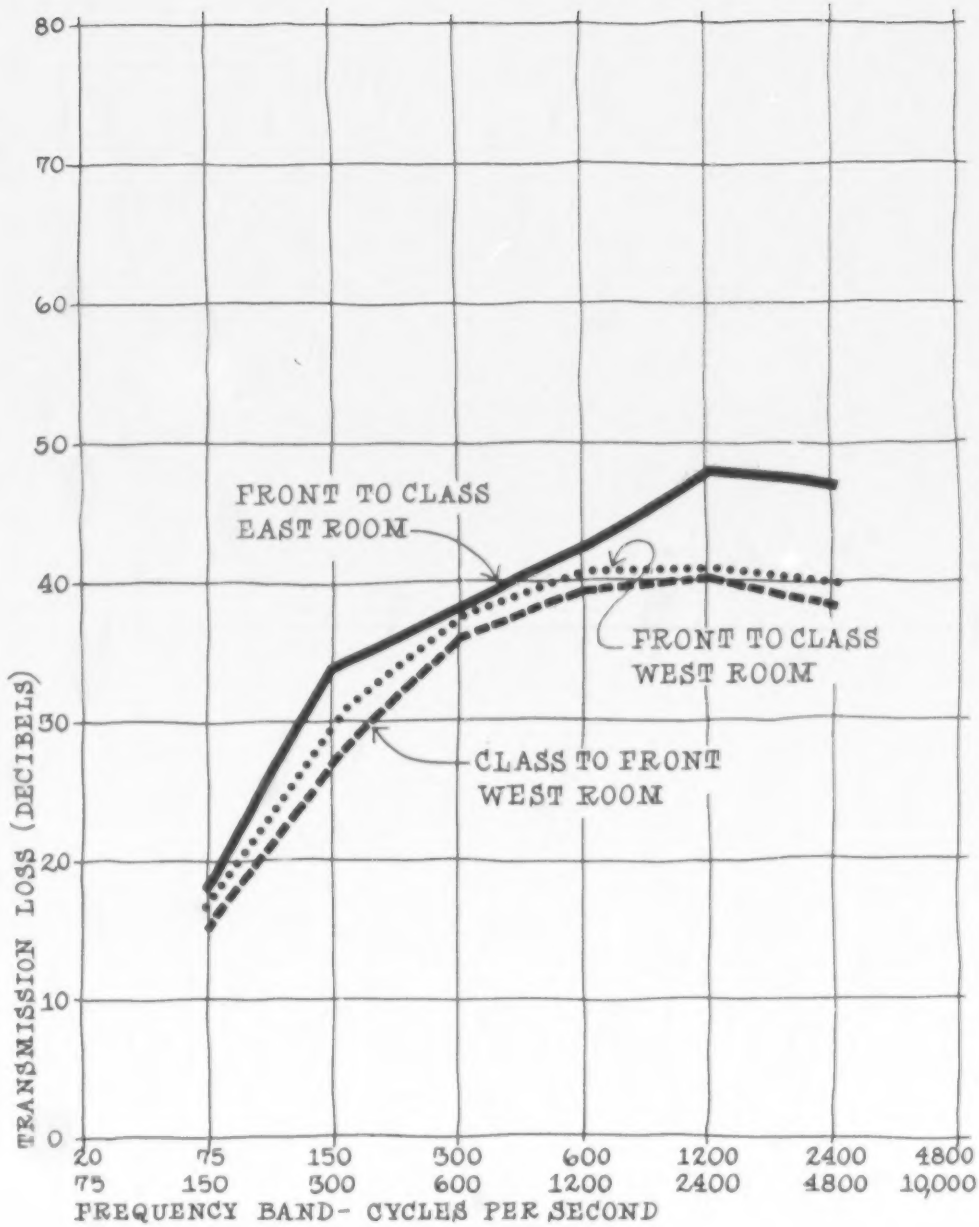
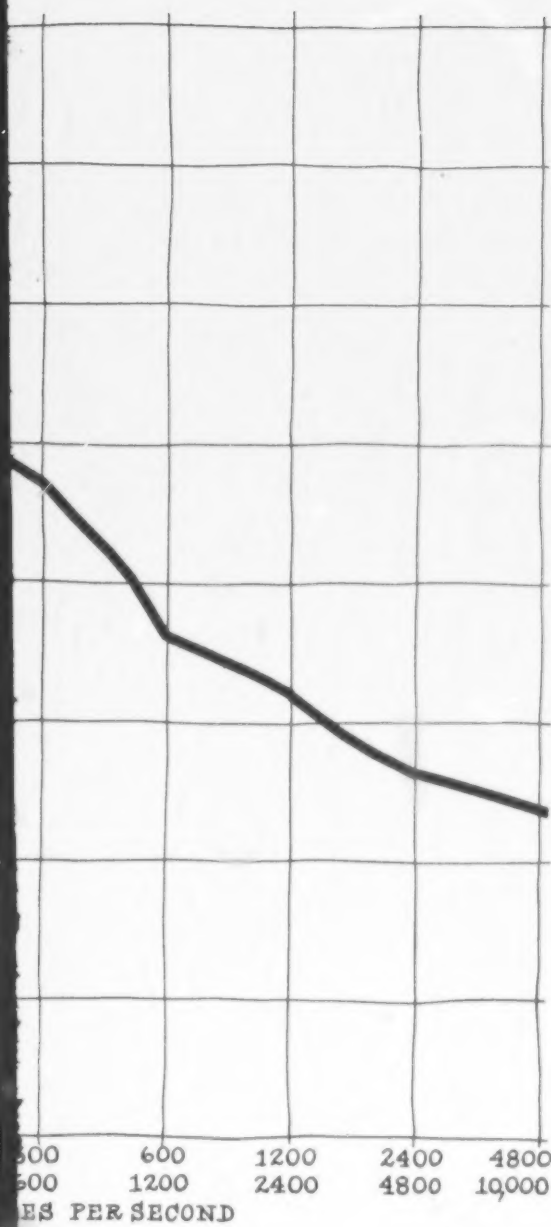


Figure 4



SECTION 2

Figure 4



dropped by about 8 decibels. As it now stands, the noise from the air conditioning systems which are suspended between the roof and ceiling is to me disturbingly "rumbly."

The remaining figure shows the measured transmission losses (the acoustician's hocus pocus to normalize the sound isolation numbers), which are useful primarily in comparing data from one installation to data from another. Theoretically, since the partitions are both constructed the same and we have normalized the absorption differences between the large room and the small rooms, all three of these curves should precisely coincide. Again, as in the case of the noise reduction figures, I account for the low frequency discrepancy as experimental error and the high frequency discrepancy as flanking...

A number of incidental points arose regarding the design which might affect subsequent building designs of this type. It is extremely unfortunate that observation ports were not provided [from the audio-visual room] into the side classrooms, and further, that the sound system controls for each room were not located below the corresponding observation window. As it is now, there is no visual connection between the side rooms and the audio-visual room, and only an indirect one from the sound control position into the main room...

Regarding the operation of the doors, this is undoubtedly the easiest installation to operate that I have ever seen. The minor problem of holding the key for a period of up to two minutes could be made more comfortable if a larger handle were provided... I think it would also be desirable to have the pocket doors connected by some mechanism so that when you open the pocket door on one side, the other one also opens.

In the Boulder installation, the space from the top of the track to the underside of the roof deck within the pocket has leaks and appears to be made of an insufficiently heavy material. I suspect the leaks predominate [since] this can be almost entirely compensated by reclosing the pocket doors after the partition is in the extended position. It is very probable that this influenced the high frequency end of my data on the west room because neither of the pocket doors could be

closed tightly against the faces of the partition.

In conclusion, I think the Boulder installation is an excellent prototype. There are indeed some "bugs," but by and large, the point we wanted to make is well made: namely that it is possible to subdivide effectively a large room into smaller teaching spaces even when audio-visual devices are being used... We would, however, certainly like to emphasize that this success was not achieved by chance. It would be unfortunate if other architects were to assume that any old door, any old air conditioning system, or any old loudspeaker system could be installed with anything like the same results.

Sincerely yours,



William R. Farrell

BOLT BERANEK AND NEWMAN INC.

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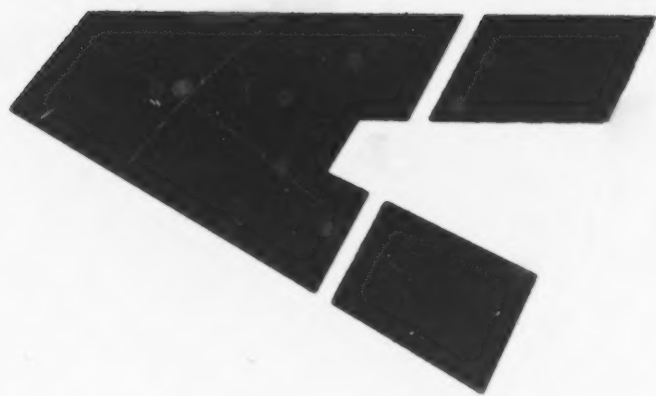
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3. *Laboratories and Classrooms for High School Physics*. Reprinted from *Modern Physics Buildings: Design and Function*.

EFL College Newsletter



SECTION 1

SECTION 2